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Temperature dependence of water self-diffusion through lipid bilayers assessed by NMR

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Abstract

The temperature dependence of the coefficient of water self-diffusion across plane-parallel multib-ilayers of dioleoylphosphatidylcholine oriented on a glass support was studied in the 20-60°C range by pulsed field gradient NMR. The coefficient for transbilayer diffusion of water proved almost four orders of magnitude smaller than for bulk water, and 10 times smaller than that for lateral diffusion of lipid under the same conditions. The temperature dependence obeyed the Arrhenius law with apparent activation energy of 41 kJ/mol, much higher than that for bulk water (18 kJ/mol). The experimental data were analyzed using the "dissolution-diffusion" model, by simulating water passage through membrane channels, and by examining water exchange in states with different modes of translational mobility, including pore channels and bilayer defects. Each approach could take into account the role of bilayer permeability and assess the apparent activation energy for water diffusion in the hydrophobic part of the bilayer, which proved close to the value for bulk water. Estimates were obtained for water diffusion coefficients in the system, coefficients of bilayer permeability for water, and the influence of bilayer defects on the lateral and transverse diffusion coefficients. © 2008 Pleiades Publishing, Ltd.

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Keywords

Lipid bilayer, Membrane channels, Pulsed field gradient NMR, Water diffusion